WHAT IS CLAIMED IS

1. A method for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said method comprising the steps of:

(a) inputting the image sequence;

(b) acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said step (a), as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked; and

(c) measuring temporal features and spatial features of the image from the motion trajectory which is acquired as the three-dimensional volume data by said step (b).

2. A method for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said method comprising the steps of:

(a) inputting the image sequence;

(b) acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said step (a), as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

(c) acquiring a plane histogram of one of tangent planes tangent to the motion trajectory and partial planes which may be included in the motion trajectory; and

(d) measuring temporal features and spatial features of the image from the plane histogram which is acquired by said step (c).

4. A method for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said method comprising the steps of:

(a) inputting the image sequence;

(b) acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said step (a), as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

(c) acquiring a plane histogram of tangent planes tangent to the motion trajectory;

(d) estimating a velocity component of the target which moves within the region from the plane histogram acquired by said step (c);

(e) extracting a distribution of the tangent planes corresponding to the image contour of the target which moves at the velocity component estimated by said step (d), from the plane histogram acquired by said step (c); and

(f) acquiring spatial features of the image from the distribution of the tangent planes extracted by said step (e).

5. 4
~~4.~~ The method as claimed in claim ~~3~~, wherein said step (d) includes the substeps of:

(d1) acquiring a histogram of intersection lines of the tangent planes from the plane histogram acquired by said step (c); and

(d2) acquiring, as image features, a most dominant translational velocity component of the target which moves within the defined region, from the histogram of the intersection lines acquired by said substep (d2).

6. 4
~~5.~~ The method as claimed in claim ~~3~~, wherein said step (d) includes the substeps of:

(d1) acquiring a histogram of intersection lines of the tangent planes from the plane histogram acquired by said step (c); and

(d2) detecting a plurality of peaks from the histogram of the intersection lines acquired by said substep (d1);

(d3) acquiring velocity components of a plurality of motions within the region corresponding to the plurality of peaks detected by said substep (d2); and

(d4) judging whether or not each of the velocity components can be represented by a composite velocity of other velocity components, with respect to the velocity components acquired by said substep (d3), and outputting an independent velocity component which cannot be represented by the composite velocity of the other velocity components.

7. 4
~~6.~~ The method as claimed in claim ~~3~~,

wherein said step (e) extracts a distribution of tangent planes along tangent line directions to the image contour of the target, and said step (f) calculates feature values related to a directionality of the image contour of the target from the distribution of the tangent planes extracted by said step (e).

8. The method as claimed in claim 4, wherein said step (e) extracts a distribution of tangent planes in directions perpendicular to a direction of the image contour of the target, and said step (f) extracts features related to a spatial arrangement of the image contour of the target.

11. A method for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said method comprising the steps of:

(a) inputting the image sequence;

(b) acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said step (a), as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

(c) acquiring a plane histogram of tangent planes tangent to the motion trajectory;

(d) acquiring a histogram of intersection lines of the tangent planes from the plane histogram

acquired by said step (c);

(e) detecting a plurality of peaks from the histogram of the intersection lines acquired by said step (d); and

(e) acquiring a plurality of velocity components of motions within the region corresponding to the plurality of peaks detected by said step (e).

12. The method as claimed in claim 11, which further comprises the steps of:

(f) judging whether or not each of the velocity components can be represented by a composite velocity of other velocity components, with respect to the plurality of velocity components acquired by said step (e); and

(g) outputting an independent velocity component which cannot be represented by the composite velocity of the other velocity components.

15. A method for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said method comprising the steps of:

(a) inputting the image sequence;

(b) acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said step (a), as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

(c) acquiring a plane histogram of one of tangent planes tangent to the motion trajectory and partial planes which may be included in the motion trajectory;

(d) acquiring a normal flow histogram of normal flows of the image from the plane histogram acquired by said step (c); and

(e) acquiring temporal features of the image from the normal flow histogram acquired by said step (d).

16. 15
~~11~~. The method as claimed in claim ~~10~~, wherein said step (d) acquires a normal flow histogram having direction and velocity of the normal flows as variables, and said step (e) calculates spreading of the normal flow histogram as feature values representing motion uniformity of the image.

17. 15
~~12~~. The method as claimed in claim ~~10~~, wherein said step (d) acquires a normal flow histogram having velocity of the normal flows as a variable, and said step (e) calculates a ratio of totalled frequency value corresponding to normal flows having specific velocities with respect to a totalled frequency value as a whole as feature values representing the motion of the image.

20.
~~13~~. A method for extracting image features

from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said method comprising the steps of:

(a) inputting the image sequence;

(b) acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said step (a), as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

(c) detecting tangent planes tangent to the motion trajectory;

(d) extracting, as an image, a distribution of the motion trajectory existing on the tangent planes detected by said step (c); and

(e) tracking a motion trajectory on the image extracted by said step (d) and detecting an occlusion of the target.

21. ~~14.~~ The method as claimed in claim 20 ~~13~~, wherein said step (e) includes the substeps of:

(e1) measuring intermittence along a moving direction of the motion trajectory; and

(e2) detecting the occlusion of the target based on the intermittence measured by said substep (e1).

22. ~~15.~~ The method as claimed in claim 20 ~~13~~, wherein said step (e) includes the substeps of:

(e1) measuring statistics of a run length along a moving direction of the motion trajectory; and

(e2) detecting a degree of the occlusion of the target from the statistics of the run length measured by said substep (e1).

~~16~~ 23. The method as claimed in claim ~~13~~ 20, wherein said step (c) detects the tangent planes in a form of a histogram of the tangent planes which are represented as a distribution of votes accumulated in a plane parameter space obtained by use of a three-dimensional Hough transform.

~~17~~ 24. The method as claimed in claim ~~13~~ 20, wherein said step (c) detects tangent planes corresponding estimated velocity components.

18. The method as claimed in ~~any of claims 1, 2, 3, 8, 10 and 13,~~ claim 1 wherein the three-dimensional volume data is obtained by forming difference images among the frames in time sequence, and stacking the formed difference images.

~~19~~ 2. The method as claimed in ~~any of claims 2, 3, 8 and 10~~ claim 1, wherein the plane histogram is obtained as votes accumulated in a plane parameter space obtained by use of a three-dimensional Hough

transform.

20. An equipment for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said equipment comprising:

first means for inputting the image sequence;

second means for acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first means, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked; and

third means for measuring temporal features and spatial features of the image from the motion trajectory which is acquired as the three-dimensional volume data by said second means.

26. An equipment for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said equipment comprising:

first means for inputting the image sequence;

second means for acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first means, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

third means for acquiring a plane histogram of one of tangent planes tangent to the motion trajectory and partial planes which may be included in the motion trajectory; and

fourth means for measuring temporal features and spatial features of the image from the plane histogram which is acquired by said third means.

29.
~~22~~. An equipment for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said equipment comprising:

first means for inputting the image sequence;

second means for acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first means, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

third means for acquiring a plane histogram of tangent planes tangent to the motion trajectory;

fourth means for estimating a velocity component of the target which moves within the region from the plane histogram acquired by said third means;

fifth means for extracting a distribution of the tangent planes corresponding to the image contour of the target which moves at the velocity component estimated by said fourth means, from the plane histogram acquired by said third means; and

sixth means for acquiring spatial features of the image from the distribution of the tangent planes extracted by said fifth means.

30. 29
23. The equipment as claimed in claim 22, wherein said fourth means includes:

seventh means for acquiring a histogram of intersection lines of the tangent planes from the plane histogram acquired by said third means; and

eighth means for acquiring, as image features, a most dominant translational velocity component of the target which moves within the defined region, from the histogram of the intersection lines acquired by said seventh means.

32. 29
24. The equipment as claimed in claim 22, wherein said fourth means includes:

seventh means for acquiring a histogram of intersection lines of the tangent planes from the plane histogram acquired by said third means; and

eighth means for detecting a plurality of peaks from the histogram of the intersection lines acquired by said seventh means;

ninth means for acquiring velocity components of a plurality of motions within the region corresponding to the plurality of peaks detected by said eighth means; and

tenth means for judging whether or not each of the velocity components can be represented by a composite velocity of other velocity components, with respect to the velocity components acquired by said ninth means, and outputting an independent velocity component which cannot be represented by the composite velocity of the other velocity components.

33. 29
25. The equipment as claimed in claim 22, wherein said fifth means extracts a distribution of tangent planes along tangent line directions to the image contour of the target, and said sixth means calculates feature values related to a directionality of the image contour of the target from the distribution of the tangent planes extracted by said fifth means.

34. 29
26. The equipment as claimed in claim 22, wherein said fifth means extracts a distribution of tangent planes in directions perpendicular to a direction of the image contour of the target, and said sixth means extracts features related to a spatial arrangement of the image contour of the target.

37.
27. An equipment for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said equipment comprising:

first means for inputting the image sequence;

second means for acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first means, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

third means for acquiring a plane histogram of tangent planes tangent to the motion trajectory;

fourth means for acquiring a histogram of

intersection lines of the tangent planes from the plane histogram acquired by said third means;

fifth means for detecting a plurality of peaks from the histogram of the intersection lines acquired by said fourth means; and

sixth means for acquiring a plurality of velocity components of motions within the region corresponding to the plurality of peaks detected by said fifth means.

38. ~~28.~~ The equipment as claimed in claim 37 ~~27~~, which further comprises:

seventh means for judging whether or not each of the velocity components can be represented by a composite velocity of other velocity components, with respect to the plurality of velocity components acquired by said fifth means; and

eighth means for outputting an independent velocity component which cannot be represented by the composite velocity of the other velocity components.

40. ~~29.~~ An equipment for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said equipment comprising:

first means for inputting the image sequence;

second means for acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first means, as three-dimensional volume data drawn within a

spatiotemporal space in which each of the frames is time-sequentially stacked;

third means for acquiring a plane histogram of one of tangent planes tangent to the motion trajectory and partial planes which may be included in the motion trajectory;

fourth means for acquiring a normal flow histogram of normal flows of the image from the plane histogram acquired by said third means; and

fifth means for acquiring temporal features of the image from the normal flow histogram acquired by said fourth means.

41. ~~30~~. The equipment as claimed in claim 40 ~~29~~, wherein said fourth means acquires a normal flow histogram having direction and velocity of the normal flows as variables, and said fifth means calculates spreading of the normal flow histogram as feature values representing motion uniformity of the image.

42. ~~31~~. The equipment as claimed in claim 40 ~~29~~, wherein said fourth means acquires a normal flow histogram having velocity of the normal flows as a variable, and said fifth means calculates a ratio of totalled frequency value corresponding to normal flows having specific velocities with respect to a totalled frequency value as a whole as feature values representing the motion of the image.

45.
32. An equipment for extracting image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said equipment comprising:

first means for inputting the image sequence;

second means for acquiring a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first means, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

third means for detecting tangent planes tangent to the motion trajectory;

fourth means for extracting, as an image, a distribution of the motion trajectory existing on the tangent planes detected by said third means; and

fifth means for tracking a motion trajectory on the image extracted by said fourth means and detecting an occlusion of the target.

46.
33. The equipment as claimed in claim 45 32, wherein said fifth means includes:

sixth means for measuring intermittence along a moving direction of the motion trajectory; and

seventh means for detecting the occlusion of the target based on the intermittence measured by said sixth means.

47.
34. The equipment as claimed in claim 45 32, wherein said fifth means includes:

sixth means for measuring statistics of a run length along a moving direction of the motion trajectory; and

seventh means for detecting a degree of the occlusion of the target from the statistics of the run length measured by said sixth means.

48. 45
~~36~~. The equipment as claimed in claim ~~32~~, wherein said third means detects the tangent planes in a form of a histogram of the tangent planes which are represented as a distribution of votes accumulated in a plane parameter space obtained by use of a three-dimensional Hough transform.

49. 45
~~38~~. The equipment as claimed in claim ~~32~~, wherein said third means detects tangent planes corresponding estimated velocity components.

37. The equipment as claimed in ~~any of claims 20, 21, 22, 27, 29 and 32~~ claim 20, wherein the three-dimensional volume data is obtained by forming difference images among the frames in time sequence, and stacking the formed difference images.

27. 26
~~38~~. The equipment as claimed in ~~any of~~ claim ~~27~~

claims 21, 22, 23 and 29, wherein the plane histogram is obtained as votes accumulated in a plane parameter space obtained by use of a three-dimensional Hough transform.

39. A computer-readable recording medium recorded with a program for causing a computer to extract image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said program comprising:

a first code for causing the computer to input the image sequence;

a second code for causing the computer to acquire a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first code, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked; and

a third code for causing the computer to measure temporal features and spatial features of the image from the motion trajectory which is acquired as the three-dimensional volume data by said second code.

51. ~~40~~. A computer-readable recording medium recorded with a program for causing a computer to extract image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said program comprising:

a first code for causing the computer to input the image sequence;

a second code for causing the computer to acquire a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first code, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

a third code for causing the computer to acquire a plane histogram of one of tangent planes tangent to the motion trajectory and partial planes which may be included in the motion trajectory; and

a fourth code for causing the computer to measure temporal features and spatial features of the image from the plane histogram which is acquired by said third code.

54. A computer-readable recording medium recorded with a program for causing a computer to extract image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said program comprising:

a first code for causing the computer to input the image sequence;

a second code for causing the computer to acquire a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first code, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

a third code for causing the computer to acquire

a plane histogram of tangent planes tangent to the motion trajectory;

a fourth code for causing the computer to estimate a velocity component of the target which moves within the region from the plane histogram acquired by said third code;

a fifth code for causing the computer to extract a distribution of the tangent planes corresponding to the image contour of the target which moves at the velocity component estimated by said fourth code, from the plane histogram acquired by said third code; and

a sixth code for causing the computer to acquire spatial features of the image from the distribution of the tangent planes extracted by said fifth code.

55.
~~42~~. The computer-readable recording medium as claimed in claim ~~41~~ 54, wherein said fourth code includes:

seventh code for causing the computer to acquire a histogram of intersection lines of the tangent planes from the plane histogram acquired by said third code; and

an eighth code for causing the computer to acquire, as image features, a most dominant translational velocity component of the target which moves within the defined region, from the histogram of the intersection lines acquired by said seventh code.

57.
~~43~~. The computer-readable recording medium as claimed in claim ~~41~~ 54, wherein said fourth code includes:

a seventh code for causing the computer to acquire a histogram of intersection lines of the tangent planes from the plane histogram acquired by said third code; and

an eighth code for causing the computer to detect a plurality of peaks from the histogram of the intersection lines acquired by said seventh code;

a ninth code for causing the computer to acquire velocity components of a plurality of motions within the region corresponding to the plurality of peaks detected by said eighth code; and

a tenth code for causing the computer to judge whether or not each of the velocity components can be represented by a composite velocity of other velocity components, with respect to the velocity components acquired by said ninth code, and output an independent velocity component which cannot be represented by the composite velocity of the other velocity components.

58. ~~44.~~ The computer-readable recording medium as claimed in claim ~~41~~ 54, wherein said fifth code causes the computer to extract a distribution of tangent planes along tangent line directions to the image contour of the target, and said sixth code causes the computer to calculate feature values related to a directionality of the image contour of the target from the distribution of the tangent planes extracted by said fifth code.

59. ~~45.~~ The computer-readable recording medium as claimed in claim ~~41~~ 54, wherein said fifth code causes

the computer to extract a distribution of tangent planes in directions perpendicular to a direction of the image contour of the target, and said sixth code causes the computer to extract features related to a spatial arrangement of the image contour of the target.

61. ~~48.~~ A computer-readable recording medium recorded with a program for causing a computer to extract image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said program comprising:

a first code for causing the computer to input the image sequence;

a second code for causing the computer to acquire a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first code, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

a third code for causing the computer to acquire a plane histogram of tangent planes tangent to the motion trajectory;

a fourth code for causing the computer to acquire a histogram of intersection lines of the tangent planes from the plane histogram acquired by said third code;

a fifth code for causing the computer to detect a plurality of peaks from the histogram of the intersection lines acquired by said fourth code; and

a sixth code for causing the computer to acquire a plurality of velocity components of motions within

the region corresponding to the plurality of peaks detected by said fifth code.

62.
~~47~~. The computer-readable recording medium as claimed in claim ~~48~~, wherein said program further comprises:

a seventh code for causing the computer to judge whether or not each of the velocity components can be represented by a composite velocity of other velocity components, with respect to the plurality of velocity components acquired by said fifth code; and

an eighth code for causing the computer to output an independent velocity component which cannot be represented by the composite velocity of the other velocity components.

65.
~~48~~. A computer-readable recording medium recorded with a program for causing a computer to extract image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said program comprising:

a first code for causing the computer to input the image sequence;

a second code for causing the computer to acquire a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first code, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

a third code for causing the computer to acquire a plane histogram of one of tangent planes tangent to the motion trajectory and partial planes which may be included in the motion trajectory;

a fourth code for causing the computer to acquire a normal flow histogram of normal flows of the image from the plane histogram acquired by said third code; and

a fifth code for causing the computer to acquire temporal features of the image from the normal flow histogram acquired by said fourth code.

66. The computer-readable recording medium as claimed in claim 65, wherein said fourth code causes the computer to acquire a normal flow histogram having direction and velocity of the normal flows as variables, and said fifth code causes the computer to calculate spreading of the normal flow histogram as feature values representing motion uniformity of the image.

67. The computer-readable recording medium as claimed in claim 65, wherein said fourth code causes the computer to acquire a normal flow histogram having velocity of the normal flows as a variable, and said fifth code causes the computer to calculate a ratio of totalled frequency value corresponding to normal flows having specific velocities with respect to a totalled frequency value as a whole as feature values representing the motion of the image.

70.
51. A computer-readable recording medium recorded with a program for causing a computer to extract image features from an image sequence in which frames indicating images are time-sequentially arranged with respect to time, said program comprising:

a first code for causing the computer to input the image sequence;

a second code for causing the computer to acquire a motion trajectory of an image contour of a target included within a region defined by an arbitrary spatial range and time range within the image sequence input by said first code, as three-dimensional volume data drawn within a spatiotemporal space in which each of the frames is time-sequentially stacked;

a third code for causing the computer to detect tangent planes tangent to the motion trajectory;

a fourth code for causing the computer to extract, as an image, a distribution of the motion trajectory existing on the tangent planes detected by said third code; and

a fifth code for causing the computer to track a motion trajectory on the image extracted by said fourth code and detecting an occlusion of the target.

71. 70
52. The computer-readable recording medium as claimed in claim 51, wherein said fifth code includes:

a sixth code for causing the computer to measure intermittence along a moving direction of the motion trajectory; and

a seventh code for causing the computer to detect the occlusion of the target based on the intermittence measured by said sixth code.

72.
53. The computer-readable recording medium as claimed in claim 51, wherein said fifth code includes:

a sixth code for causing the computer to measure statistics of a run length along a moving direction of the motion trajectory; and

a seventh code for causing the computer to detect a degree of the occlusion of the target from the statistics of the run length measured by said sixth code.

73.
54. The computer-readable recording medium as claimed in claim 51, wherein said third code causes the computer to detect the tangent planes in a form of a histogram of the tangent planes which are represented as a distribution of votes accumulated in a plane parameter space obtained by use of a three-dimensional Hough transform.

74.
55. The computer-readable recording medium as claimed in claim 51, wherein said third code causes the computer to detect tangent planes corresponding estimated velocity components.

56. The computer-readable recording medium as claimed in ~~any of claims 39, 40, 41, 46, 48 and 51~~ claim 39, wherein the three-dimensional volume data is obtained by forming difference images among the frames in time

sequence, and stacking the formed difference images.

52.
57. The computer-readable recording medium as claimed in ~~any of claims 40, 41, 42, 46 and 48,~~ claim 40 or 51 wherein the plane histogram is obtained as votes accumulated in a plane parameter space obtained by use of a three-dimensional Hough transform.

Add B1)